Modeling the Time-Dependent Optical Properties of the Multicomponent Aerosols in the Marine Boundary Layer

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LONG-TERM GOALS

Relate the time-dependent, frequency-dependent, radiative properties of multicomponent aerosols to their major physical and chemical transformation processes in the marine boundary layer.

OBJECTIVES

Develop algorithms for the calculation of frequency-dependent optical properties of mineral dust accounting for its mineralogical composition, life-cycle, and interaction with other atmospheric aerosols in the marine boundary layer.

Incorporate the dust optical models into an aerosol chemical-microphysical model. Use the model to simulate the dynamics of the multicomponent marine aerosol size distribution and composition. Develop simplified physically-based treatments of time-dependent aerosol radiative properties.

Apply the developed models to analyze high-spectral resolution remote sensing data.

APPROACH

Our approach combines analysis of empirical data on dust microphysical, optical, and radiative properties along with mathematical modeling based on an operational three-dimensional aerosol chemical-microphysical model.

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WORK COMPLETED

We developed a new technique to model the spectral optical properties of mineral aerosol accounting for its composition. A spectral dust optical model was calculated for a wide range of wavelengths from 0.2 to 30 micrometers.

We are incorporating dust into a 3-D coupled aerosol-chemical model, and are performing test runs of optical properties of multicomponent (dust plus others) aerosols in marine conditions.

We incorporated a simplified dust parameterization into a 3-D global circulation model (GCM) driven by observed winds. We simulated evolution of dust particle size distribution and optical properties during dust transport.

Overall, we successfully completed all tasks planned for FY98.

RESULTS

Our modeling, employing Mie theory and a data set of refractive indices of major minerals, shows that existing variations in mineralogical composition of dust from different locations can cause large changes in the major aerosol spectral optical properties. Therefore, we conclude that incorporation of space- and time-varying mineralogical composition of dust is required for remote sensing retrievals using channels operating at wavelengths from UV to IR. We defined the major components of mineral aerosol which should be taken into consideration to correctly represent the spectral dust optical properties.

IMPACT/APPLICATIONS

Our new technique to model the spectral optical properties of mineral aerosol accounting for its composition can be employed in various remote sensing applications.

TRANSITIONS

Our main results were published in the peer-reviewed journals.

We compiled a data set of refractive indices of mineral aerosols collected at various geographical locations that will be available via WWW.

RELATED PROJECTS

We are currently independently funded under the NASA EOS-IDS program to construct an "event oriented" global model for atmospheric aerosols. The goal is to develop a tool which can directly compare satellite observations of aerosols generated by specific events with output from a numerical model. This linkage should help with the satellite retrieval algorithms, allow observations by multiple satellites or ground campaigns to be intercompared for the same event, and give us greater confidence in our ability to simulate aerosol systems.

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